

U.S. DEPARTMENT OF COMMERCE, PATENT AND TRADEMARK OFFICE		DATE: <b>July 6, 2000</b>
<b>TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EQ/US) CONCERNING A FILING UNDER 35 U.S.C. 371</b>		U.S. APP. NO. (if known) <b>097582874</b>
INTERNATIONAL APPLICATION NO.: <b>PCT/JP98/06014</b>	INTERNATIONAL FILING DATE: <b>DECEMBER 28, 1998</b>	PRIORITY DATE CLAIMED: <b>JANUARY 8, 1998</b>
TITLE OF INVENTION: <b>NOTIFYING DEVICE AND WIRELESS COMMUNICATIONS SYSTEM INCORPORATING SAME</b>		
APPLICANT(S) FOR DO/EQ/US: <b>Toshihide HAMAGUCHI and Hirokazu GENNO</b>		
Applicant hereby submits to the United States Designated/Elected Office (DO/EQ/US) the following items and other information:		
<p>1. <u>XX</u> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</p> <p>2. <u>    </u> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</p> <p>3. <u>XX</u> This express request to begin national examination procedures (35 USC 371(f)) at any time rather than delay examination until the expiration of the time limit set in 35 USC 371(b) and PCT Articles 22 and 39(1).</p> <p>4. <u>XX</u> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.</p> <p>5. <u>XX</u> A copy of the International Application as filed (35 U.S.C. 371(c)(2)):</p> <p>a. <u>    </u> is transmitted herewith (required only if not transmitted by the International Bureau).</p> <p>b. <u>XX</u> has been transmitted by the International Bureau.</p> <p>c. <u>    </u> is not required, as the application was filed in the United States Receiving Office (RO/US)</p> <p>6. <u>XX</u> A translation of the International Application into English (35 U.S.C. 371(c)(2)).</p> <p>7. <u>XX</u> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))</p> <p>a. <u>    </u> are transmitted herewith (required only if not transmitted by the International Bureau).</p> <p>b. <u>    </u> have been transmitted by the International Bureau.</p> <p>c. <u>    </u> have not been made; however, the time limit for making such amendments has NOT expired.</p> <p>d. <u>XX</u> have not been made and will not be made.</p> <p>8. <u>    </u> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</p> <p>9. <u>XX</u> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</p> <p>10. <u>XX</u> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</p> <p><b>ITEMS 11. TO 16. BELOW CONCERN OTHER DOCUMENT(S) OR INFORMATION INCLUDED:</b></p> <p>11. <u>    </u> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</p> <p>12. <u>XX</u> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</p> <p>13. <u>XX</u> A <b>FIRST</b> preliminary amendment.</p> <p><u>    </u> A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment</p> <p>14. <u>    </u> A substitute specification.</p> <p>15. <u>    </u> A change of power of attorney and/or address letter.</p> <p>16. <u>XX</u> Other items or information: 10 sheets of drawings and International Search Report</p>		

U.S. APPLICATION NO. (if known) <b>09/582874</b>		INTERNATIONAL APPLICATION NO. <b>PCT/JP98/06014</b>		DATE: <b>July 6, 2000</b>	
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17. <u>X</u> The following fees are submitted:  <b>Basic National Fee (37 CFR 1.492(a)(1)-(5):</b> Search Report has been prepared by the EPO or JPO: ..... \$840.00  International preliminary examination fee paid to USPTO (37 CFR 1.482) ..... \$670.00  No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) ..... \$690.00  Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$970.00  International preliminary examination fee (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) ..... \$ 96.00  <div style="text-align: right;"><b>ENTER APPROPRIATE BASIC FEE AMOUNT = \$ 840.00</b></div>				<u>CALCULATIONS</u>		<u>PTO USE ONLY</u>	
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Surcharge of <b>\$130.00</b> for furnishing the oath or declaration later than <u>  </u> 20 30 months from the earliest claimed priority date (37 CFR 1.492(e)).							
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CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
TOTAL	17 - 20 =		X \$ 18.00		
INDEPENDENT	3 - 3 =		X \$ 78.00		
Multiple dependent claims(s) (if applicable)			+ \$260.00		
<b>TOTAL OF ABOVE CALCULATIONS =</b>				<b>\$ 840.00</b>	

Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).							
<b>SUBTOTAL =</b>				<b>\$ 840.00</b>			


Processing fee of <b>\$130.00</b> for furnishing the English translation later than <u>  </u> 20 30 months from the earliest claimed priority date (37 CFR 1.492(f)).							
<b>TOTAL NATIONAL FEE =</b>				<b>\$ 840.00</b>			

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). <div style="text-align: right;"><b>\$40.00 per property +</b></div>							
<b>TOTAL FEES ENCLOSED =</b>				<b>\$ 880.00</b>			

				Amount to be:			
				refunded	\$		
				charged	\$		

U.S. APPLICATION NO. (if known) <b>09/582874</b>	INTERNATIONAL APPLICATION NO.  <b>PCT/JP98/06014</b>	DATE: <b>July 6, 2000</b>
<p>a. <input checked="" type="checkbox"/> A check in the amount of \$ <b>880.00</b> to cover the above fees is enclosed. (This paper is filed in triplicate)</p> <p>b. <input type="checkbox"/> Please charge my Deposit Account No. 01-2340 in the amount of \$___ to cover the above fees. (A duplicate copy of this sheet is enclosed.)</p> <p>c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 01-2340.</p> <p><b>NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed to request that the application be restored to pending status.</b></p> <p>Send All Correspondence To:</p> <p>ARMSTRONG, WESTERMAN, HATTORI McLELAND &amp; NAUGHTON 1725 K Street, N.W. Suite 1000 Washington, D.C. 20006 (202) 659-2930</p> <p> SIGNATURE</p> <p><b>Donald W. Hanson</b> NAME</p> <p><b>27.133</b> REGISTRATION NUMBER</p>		

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## SPECIFICATION

NOTIFYING DEVICE AND WIRELESS COMMUNICATIONS SYSTEM  
INCORPORATING SAME

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## TECHNICAL FIELD

The present invention relates to notifying devices for use in portable telephones, pagers and like wireless communications systems for notifying the user of incoming calls.

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## BACKGROUND ART

Conventional portable telephones have incorporated therein a sound generator (ringer) for notifying the user of incoming calls with sound, i.e., with a vibration having a frequency in the audible range and a vibration generator for notifying the user of incoming calls with a vibration perceivable by the human body and having a frequency, for example, of up to hundreds of hertz. One of the two generators is selectively usable according to the situation.

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However, small devices such as portable telephones have little or no excessive space for accommodating both the sound generator and the vibration generator, and therefore encounter the problem of becoming greater in size if equipped with the two generators.

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Accordingly, the present applicant has proposed a portable telephone as shown in FIG. 9 (JP-A No. 14194/1998).

The proposed portable telephone comprises a flat case 11 having an antenna 1 and provided on the surface thereof with a speech receiving portion 12 for outputting the voice of incoming speech, manual buttons 14 such as numerical keys, a speech delivery portion 13 for inputting the voice of outgoing speech, etc. Provided in a suitable portion of the interior of the case 11 is a notifying unit 2 for notifying the user of incoming calls with sound, vibration or both sound and vibration.

The notifying unit 2 comprises a first vibrator drivable with a first drive signal at a frequency in the audible range for producing sound waves, a second vibrator drivable with a second drive signal at a second frequency (up to hundreds of hertz) lower than the first frequency for producing a vibration, and a signal generator circuit for producing the first drive signal and the second drive signal. The first vibrator and the second vibrator are housed in a common casing. The first vibrator comprises a coil attached by a first diaphragm to the casing, while the second vibrator comprises a magnet attached by a second diaphragm to the casing. The magnet is formed with a magnetic gap having the coil of the first vibrator

accommodated therein.

Stated more specifically with reference to FIG. 2, the notifying unit comprises as housed in a cylindrical casing 21 a first vibrator 4 for producing sound waves mainly and a second vibrator 3 for producing vibration mainly. The casing 21 has a compact structure in its entirety and comprises a hollow cylindrical body 22, an annular front cover member 24 having a sound emitting aperture 25 and attached to an open front side of the body 22, and an annular rear cover member 23 attached to an open rear side of the body 22.

The first vibrator 4 comprises a circular first diaphragm 41 having its peripheral portion held between the casing body 22 and the front cover member 24, and a coil 42 fixed to the rear side of the first diaphragm 41. The first vibrator 4 has a resonance frequency in an audible range in excess of hundreds of hertz.

On the other hand, the second vibrator 3 comprises an annular second diaphragm 34 having its peripheral portion held between the casing body 22 and the rear cover member 23, an outer yoke 32 secured to the inner peripheral portion of the second diaphragm 34, a permanent magnet 31 magnetized axially thereof (vertical direction) and fixed to the front side of the outer yoke 32, and an inner yoke

33 fixed to the front side of the magnet 31. The coil 42 of the first vibrator 4 is accommodated upwardly or downwardly movably in an annular magnetic gap defined by opposed faces of the outer yoke 32 and the inner yoke 33.

5 The second vibrator 3 has a low resonance frequency of lower than hundreds of hertz.

FIG. 11 shows the vibration characteristics  $C_s$  of the first vibrator 4 and the vibration characteristics  $C_v$  of the second vibrator 3. The vibrators 4, 3 exhibit a peak  
10 in amplitude at the resonance frequencies  $F_s$ ,  $F_v$ , respectively.

Accordingly, great notification effects are available by feeding a sound drive signal and a vibration drive signal of these respective resonance frequencies  $F_s$ ,  $F_v$  to  
15 the coil 42 of the notifying unit 2.

More specifically, a sound drive signal  $D_s$  of a frequency (for example, about 2 kHz) in match with the resonance frequency  $F_s$  as shown in FIG. 10, (a) is fed to the coil 42 when notifying with sound, and a vibration  
20 drive signal  $D_v'$  of a frequency (for example, about 100 Hz) in match with the resonance frequency  $F_v$  as shown in FIG. 10, (b) is fed to the coil 42 when notifying with vibration.

When the sound drive signal  $D_s$  is fed to the coil 42 of the notifying unit 2, the coil 42 produces an axial

drive force by virtue of the relationship between the magnetic lines of force extending through the magnetic gap radially thereof and the circumferential current flowing through the coil 42 according to the Fleming's left-hand rule. Since the drive force acts at the frequency of the resonance point, the first vibrator 4 resonates to generate sound waves, while the second vibrator 3 remains almost free of vibration because the resonance point thereof is different. The generation of sound waves gives audio notification of an incoming call.

On the other hand, when the vibration drive signal  $Dv'$  is fed to the coil 42 of the notifying unit 2, the coil 42 similarly produces an axial drive force. Since the resonance point of the first vibrator 4 differs from the frequency of the drive force, the first vibrator 4 undergoes almost no vibration, but the second vibrator 3 which has a resonance point at the frequency of the drive force is resonated by the reaction of the drive force to produce vibration. The vibration generated is perceived by the human body, notifying the user of an incoming call.

With the notifying unit 2, the resonance frequencies of the vibrators 4, 3 inevitably involve variations due to tolerances for the specifications for determining the resonance frequencies of the vibrators 4, 3, such as the

configurations, dimensions, materials, etc. of the diaphragms 41, 34, yokes 32, 33 and permanent magnet 31. For example, the thickness of the second diaphragm 34 constituting the second vibrator 3 has a tolerance of 120  $\mu\text{m} \pm 8 \mu\text{m}$ . In the case where the resonance frequency  $F_v$  is 100 Hz when the diaphragm thickness  $t$  is 120  $\mu\text{m}$ , the variation in the resonance frequency is  $100 \text{ Hz} \pm 10 \text{ Hz}$  since the resonance frequency  $F_v$  is in proportion to the thickness  $t$  raised to the index 1.5.

- 10        FIG. 12 shows vibration characteristics a in a solid line as varied by dimensional tolerances, etc. to vibration characteristics b, c in a broken line, respectively. If a vibrator having the vibration characteristics b involving a variation is driven at the resonance frequency of the
- 15        vibration characteristics a with no variation, no resonance occurs, and the amplitude of the vibrator will greatly decrease from a peak value  $W_p$  at the resonance point to a value  $W'$ . Thus in the case where the notifying unit is
- 20        driven with a drive signal of given frequency without considering the variation of the resonance frequency, there arises the problem that variations occur also in the amplitude of the vibrator, failing to produce a satisfactory notifying effect.

Further portable telephones in recent years can be set

in various operation modes, for example, to display the telephone number of the caller upon receiving an incoming call or to serve as a pager. In conformity with such a wider variety of operational functions, there arises a need  
5 for the notifying unit to give notification not only of incoming calls but also of the various modes in which the telephone is set.

Accordingly, a first object of the present invention is to provide a notifying device which produces  
10 satisfactory notifying effects despite the variation in resonance frequency, and a wireless communications system incorporating the device.

A second object of the invention is to provide a wireless communications system comprising a notifying  
15 device adapted for different kinds of notifying operations including notification of incoming calls to give satisfactory notifying effects despite the variation in resonance frequency.

#### DISCLOSURE OF THE INVENTION

20 To fulfill the first object, the present invention provides a notifying device comprising a vibrator to be resonated by a drive signal fed thereto, and a signal preparing circuit for feeding the drive signal to the vibrator, the notifying device being characterized in that

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tolerances for the specifications can be determined experimentally, empirically or theoretically, and the variation in the frequency of the drive signal can be determined reasonably when made to correspond to the  
5 variation thus determined.

The resonance frequency of the vibrator is an actually inaudible low frequency, for example, of up to hundreds of hertz, and the vibration of the vibrator at the resonance frequency has an amplitude which is generally perceivable  
10 by the human body, whereby a perceivable notifying effect can be obtained.

The drive signal has an alternating waveform of pulses or sine waves having a frequency which periodically varies preferably at 0.5 to 10 Hz, more preferably at 1.37 to 2.98  
15 Hz, most preferably at 2.18 Hz. This periodically produces resonance of highly perceivable effect.

The frequency of the drive signal further varies in the form of triangular waves, sine waves or sawtooth waves. Especially when the frequency of the drive signal is  
20 varied in the form of sawtooth waves, resonance occurs with a definite period in match with the period of the waves, ensuring notification without discomfort. The frequency of the drive signal need not always be varied continuously but may be gradually increased or decreased stepwise.

The present invention provides a wireless communications system comprising the notifying device of the invention described for notifying the user of incoming calls. The system produces a satisfactory notifying effect even if the resonance frequency of the notifying device involves a variation, thus giving reliable notification of incoming calls.

With the notifying device and the wireless communications system incorporating the device according to the invention, periodic or nonperiodic occurrence of resonance repeatedly increases the amplitude of the vibrator to the amplitude of resonance as a peak and decreases the amplitude from the peak, affording effective notification which is audible or perceivable by the human body.

To fulfill the second object, the present invention provides a wireless communications system which has incorporated therein a notifying device for performing different kinds of notifying operations including notification of incoming calls, the notifying device comprising a vibrator to be resonated by a drive signal fed thereto, and a drive signal feed circuit for feeding the drive signal to the vibrator. The drive signal feed circuit comprises command signal preparing means for

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preparing notification command signals which are different for different contents of notification in conformity with the content, and drive signal preparing means operative in response to the notification command signal to prepare a  
5 drive signal which varies in frequency within a predetermined range including the resonance frequency of the vibrator and which differs in the state of variation for the different notification command signals and to feed the drive signal to the vibrator.

- 10 Even if the vibrator has a resonance frequency involving a variation due to dimensional tolerances, etc. of the vibrator, the drive signal repeatedly varies in frequency within the predetermined range, so that resonance occurs to give a great amplitude when the frequency of the  
15 drive signal matches the true resonance frequency during the variation. When the frequency of the drive signal thereafter becomes different from the true resonance frequency, the vibrator undergoes no resonance and exhibits a diminished amplitude, whereas the amplitude increases  
20 when the signal frequency matches the true resonance frequency again. In this way, the amplitude of the vibrator repeatedly increases to the amplitude of resonance as a peak and decreases therefrom as the frequency of the drive signal varies.

Further in response to an incoming call or in accordance with other operation of the system, a specific notification command signal is prepared for notifying the use of the operation, and a drive signal is prepared with  
5 reference to the command signal for driving the vibrator in a different state of vibration. Upon receiving a usual incoming call, for example, a first drive signal is prepared wherein the variation of the vibration frequency continues, based on an incoming call notification command  
10 signal. Upon receiving an incoming call from a specified caller, on the other hand, a second drive signal is prepared which turns on and off with a predetermined period, based on a caller notification command signal. When the notifying device is driven with the first drive signal,  
15 resonance occurs with a predetermined period, whereas when the notifying device is driven with the second drive signal, resonance occurs intermittently periodically. This difference in the mode of vibration enables the user to identify the caller.

20 Further when an operation mode as a telephone is set, a drive signal is prepared wherein the variation of the frequency has a first period, based on a mode notification command signal. When other operation mode, for example, for the function of a pager is set, a drive signal is



varies at one to several hertz. This periodically produces resonance with a period highly effective for perception by the human body. The frequency of the drive signal further varies in the form of triangular waves, sine waves or sawtooth waves. Especially when the frequency of the drive signal is varied in the form of sawtooth waves, resonance occurs with a definite period in match with the period of the waves, ensuring notification without discomfort. The frequency of the drive signal need not always be varied continuously but may be gradually increased or decreased stepwise.

With the wireless communications system according to the invention, periodic or nonperiodic occurrence of resonance, regardless of the variation in the resonance frequency, repeatedly increases the amplitude of the vibrator to the amplitude of resonance as a peak and decreases the amplitude from the peak, giving effective notification which is audible or perceivable by the human body. Further different states of vibration enable the user to identify the contents of notification.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing the circuit construction of a portable telephone of first embodiment of the invention.

FIG. 2 is an enlarged view in section of a notifying unit.

FIG. 3 includes waveform diagrams showing the relationship between the frequency of a drive signal and  
5 the amplitude of a vibrator.

FIG. 4 is a waveform diagram of the drive signal.

FIG. 5 includes waveform diagrams showing the relationship between the frequency of a drive signal and the amplitude of a vibrator as another example.

10 FIG. 6 is a waveform diagram showing variations in the frequency of a drive signal as another example.

FIG. 7 is a block diagram showing the construction of an example of vibrating signal processing circuit.

FIG. 8 includes waveform diagrams showing the  
15 operation of the vibrating signal processing circuit.

FIG. 9 is a perspective view showing the appearance of a portable telephone embodying the invention.

FIG. 10 includes waveform diagrams showing a sound drive signal and a vibration drive signal of a conventional  
20 portable telephone.

FIG. 11 is a graph showing the vibration characteristics of vibrators.

FIG. 12 is a diagram for illustrating a decrease in amplitude due to variations in resonance frequency.

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portion 12 incorporating a speaker, manual buttons 14 such as numerical keys, a speech delivery portion 13 incorporating a microphone, etc. Provided in a suitable portion of the interior of the case 11 is a notifying unit 5 2 for notifying the user of incoming calls with sound or vibration.

As shown in FIG. 2, the notifying unit 2 comprises as housed in a common casing 21 a first vibrator 4 for producing sound mainly and a second vibrator 3 for 10 producing vibration mainly. The casing 21 comprises a hollow cylindrical body 22, an annular front cover member 24 having a sound emitting aperture 25 and attached to an open front side of the body 22, and an annular rear cover member 23 attached to an open rear side of the body 22.

15 The first vibrator 4 comprises a circular first diaphragm 41 having its peripheral portion held between the casing body 22 and the front cover member 24, and a coil 42 fixed to the rear side of the first diaphragm 41. The first vibrator 4 has a resonance frequency in an audible 20 range in excess of hundreds of hertz.

On the other hand, the second vibrator 3 comprises an annular second diaphragm 34 having its peripheral portion held between the casing body 22 and the rear cover member 23, an outer yoke 32 secured to the inner peripheral

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portion of the second diaphragm 34, a permanent magnet 31 magnetized axially thereof (vertical direction) and fixed to the front side of the outer yoke 32, and an inner yoke 33 fixed to the front side of the magnet 31. The coil 42 of the first vibrator 4 is accommodated upwardly or downwardly movably in an annular magnetic gap defined by opposed faces of the outer yoke 32 and the inner yoke 33. The second vibrator 3 has a resonance frequency in an actually inaudible frequency range, for example, of 50 Hz to 300 Hz.

The first and second diaphragms 41, 34 can be made from a known elastic material such as metal, rubber or resin. When required, the second diaphragm 34 has cuts so as to obtain a great displacement.

FIG. 1 shows the construction of the main circuit of the portable telephone having the notifying unit 2 described. The telephone is so adapted that when pressed, the manual button 14 enables the user to select notification with sound or notification with vibration for alerting the user to incoming calls. In conformity with the selection thus made, an alert setting circuit 55 sets the selected alerting method for a control circuit 54.

A sound signal preparing circuit 57 and a vibration signal preparing circuit 5 are connected to the notifying

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unit 2 by way of a switch 59, which is changed over under the control of the control circuit 54.

Radio waves transmitted by the base station are received by the antenna 1 at all times with a specified period. The signal received is frequency-converted and demodulated by a radio circuit 51 and then fed to a signal processing circuit 52, which extracts a digital sound signal and a control signal from the signal. The operation of the signal processing circuit 52 is controlled by the control circuit 54.

The control signal obtained by the signal processing circuit 52 is fed to an incoming call detecting circuit 53, whereby an incoming call is detected if any. On the other hand, the sound signal given by the circuit 52 is fed to an unillustrated sound signal processing circuit and then output from the speaker as sound.

The sound signal preparing circuit 57 serves to produce a sound drive signal  $D_s$  of audible frequency for notification with sound. On the other hand, the vibration signal preparing circuit 5, which produces a vibration drive signal  $D_v$  having a low frequency of up to hundreds of hertz for notification with vibration perceivable by the body, comprises a modulation signal generating circuit 56 and a vibration signal processing circuit 58. The

constructions of these circuits 56 and 58 will be described later in detail.

When an incoming call is detected by the detecting circuit 53, the control circuit 54 changes over the switch 59 in accordance with the alert setting by the manual button 14. In the case where the user is to be notified of the incoming call with sound only, the switch 59 is changed over for connection to the sound signal preparing circuit 57 to feed the sound drive signal alone to the notifying unit 2. When notification is to be given only with vibration, the switch 59 is changed over for the vibration signal preparing circuit 5 to feed the vibration drive signal alone to the notifying unit 2.

With reference to FIG. 10, (a), the sound drive signal  $D_s$  produced by the sound signal preparing circuit 57 is prepared from a pulse signal having a frequency of 2 kHz in the audible range by rendering the signal intermittent at a period of 16 Hz. The resulting intermittent pulses provide a readily audible notifying sound which sounds like "pulll...." The frequency of 2 kHz matches the resonance frequency  $F_v$  of the vibration characteristics  $C_s$  shown in FIG. 11.

On the other hand, the vibration drive signal  $D_v$  prepared by the vibration signal preparing circuit 5 has a

frequency periodically varying in the range, for example,  
 of  $100 \text{ Hz} \pm 10 \text{ Hz}$  and centered about approximately 100 Hz  
 that is easily perceivable by the human body as a vibration  
 as shown in FIG. 4. The center frequency 100 Hz is in  
 5 match with the resonance frequency  $F_v$  of the vibration  
 characteristics  $C_v$  shown in FIG. 11.

FIG. 3, (a) shows an example wherein the frequency  $F$   
 of the vibration drive signal  $D_v$  is varied in the form of  
 triangular waves. The frequency  $F$  has a variation of  $\pm \Delta F$   
 10  $= \pm 10 \text{ Hz}$  with a center frequency of  $F_m = 100 \text{ Hz}$ . The  
 variation frequency  $(1/T_m)$  is in the range of 0.5 to 10 Hz.  
 The variation  $\pm \Delta F$  of the frequency is determined in  
 accordance with the variation of the resonance frequency of  
 the second vibrator 3 due to tolerances for the  
 15 specifications on which the resonance frequency is  
 dependent.

Suppose the resonance frequency of the second vibrator  
 3 involves no variation in this case. Resonance then  
 occurs when the frequency  $F$  matches the center frequency  $F_m$ ,  
 20 and an amplitude curve  $W_a$  indicated in a solid line in FIG.  
 3, (b) is obtained which has a peak amplitude  $W_p$  at the  
 resonance point.

Further suppose the resonance frequency of the second  
 vibrator 3 involves a variation due to dimensional



in the form of sine waves or sawtooth waves. For example, in the case where the frequency is varied in the form of sawtooth waves as shown in FIG. 5, (a), suppose the resonance frequency of the second vibrator 3 has no variation. An amplitude curve  $W_a$  is then obtained which has a peak amplitude  $W_p$  at the resonance point as indicated in a solid line in FIG. 5, (b). Even if the resonance frequency of the second vibrator 3 involves a variation, a resonance curve  $W_b$  will be obtained which has a peak amplitude  $W_p$  at the resonance point as indicated in a broken line in FIG. 5, (b). Notification without discomfort is realized especially in this case since the second vibrator 3 resonates at a definite period.

Alternatively, the frequency of the vibration drive signal  $D_v$  can be gradually increased or decreased stepwise in minute frequency increments or decrements as shown in FIG. 6. The same effect as above is available also in this case.

According to the present embodiment, the vibration signal preparing circuit 5 comprises a modulation signal generating circuit 56 and a vibration signal preparing circuit 58 as shown in FIG. 1. The modulation signal generating circuit 56 produces a modulation signal  $S_m$  for modulating the frequency of the vibration drive signal.

The modulation signal is prepared in the same waveform as the frequency variation waveform of the vibration drive signal shown in FIG. 3, (a) or FIG. 5, (a). Such a modulation signal can be prepared by a signal generating circuit already known.

On the other hand, the vibration signal processing circuit 58 can be, for example, of the construction shown in FIG. 7. The circuit 58 comprises a charging unit 6 composed of a capacitance element C and resistance elements R1, R2, an RS-flip-flop circuit 63 connected to the output terminal of the unit 6 via a first comparator 61 and a second comparator 62, and a discharge control transistor 64 and a T-flip-flop circuit 65 which are connected to the output terminal of the circuit 63. The modulation signal  $S_m$  is fed to an inversion input terminal of the first comparator 61, and a reference voltage signal  $V_{ref}$  to a noninversion input terminal of the second comparator 62.

FIG. 8 shows the operation of the vibration signal processing circuit 58. The charging unit 6 is charged by being supplied with power, whereby a voltage signal  $V_o$  output from the charging unit 6 is gradually increased. Upon the magnitude of the signal reaching the level of the modulation signal  $S_m$ , the first comparator 61 feeds a set signal to the RS-flip-flop circuit 63, turning on an output





alike in the tendency of sensitivity variations as apparent from the result. It is therefore thought that FIG. 13 shows the basic variation pattern of perception characteristics.

- 5       Next, an experiment was conducted with ten panelists (a to j). The wireless communications system (pager) of the invention was placed on the palm of each panelist, the variation frequency was then altered continuously, and the panelist was asked to report the modulation frequency
- 10   (optimum modulation frequency) at which the vibration was perceived with the highest sensitivity. Table 1 shows the result.

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Table 1

	<u>Panelist</u>	<u>Optimum modulation frequency [Hz]</u>
	a	2.25
	b	2.31
5	c	2.10
	d	2.03
	e	2.77
	f	2.11
	g	2.29
10	h	1.85
	i	1.83
	j	2.23
	Ave $\pm$ SD	2.177 $\pm$ 0.268

Since the optimum modulation frequency slightly  
 15 differs from person to person as will be apparent from the  
 table, the average value of the listed values, Ave = 2.177  
 Hz, can be used as a universal optimum modulation frequency.  
 Further the standard deviation SD of the optimum variation  
 frequencies listed in Table 1 is 0.268, so that if the  
 20 modulation frequency is set within a range (Ave  $\pm$  3SD)  
 three times the standard deviation centered about the  
 average value Ave, i.e., within the range of 1.37 to 2.98  
 Hz, a very high notifying effect can be given to almost all  
 users.

Second Embodiment

A portable telephone embodying the invention has incorporated therein a notifying unit which has the same construction as the notifying unit 2 of the first

5 embodiment shown in FIG. 2.

FIG. 14 shows the main circuit construction of the portable telephone of the present embodiment.

Throughout this circuit and the circuit of first embodiment shown in FIG. 1, like components are designated  
10 by like reference numerals and will not be described repeatedly.

The sound signal preparing circuit 57 serves to produce a sound drive signal  $D_s$  of audible frequency for notification with sound as in the first embodiment. On the  
15 other hand, the vibration signal preparing circuit 5, which produces a vibration drive signal  $D_v$  having a low frequency of up to hundreds of hertz for notification with vibration perceivable by the body, comprises a modulation signal generating circuit 56 and a vibration signal processing  
20 circuit 58. The constructions of these circuits 56 and 58 will be described later in detail.

An on/off switch 71 is interposed between the vibration signal preparing circuit 5 and the change-over switch 59. The modulation signal generating circuit 56 and

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sawtooth modulation signal  $S_m$  as shown in FIG. 16, (b). In this way, the period of the modulation signal  $S_m$  can be changed to one of different periods.

The control signal preparing circuit 72 prepares a  
5 change-over control signal for the switch  $S$  constituting the period change-over unit 7 and an on/off control signal for the on/off switch 71 in response to a mode notifying command signal obtained from the control circuit 54.

For example, in the case where the system has  
10 registered therein the telephone number(s) of specified one or more than one callers, and when a call is received from an unregistered caller, the incoming call is detected by the incoming call detecting circuit 53, whereupon the control circuit 54 prepares a mode notifying command signal  
15 for giving a command to notify the user of reception of the call and feeds the command signal to the control signal preparing circuit 72. The circuit 72 in turn controls the period change-over unit 7 of the modulation signal generating circuit 56, whereby a modulation signal of  
20 sawtooth waves having a predetermined period  $T_0$  is generated as shown in FIG. 17, (a), and the on/off switch 71 is held on at all times. A drive signal varying in frequency in accordance with the modulation signal is fed to the notifying unit 2. As a result, the notifying unit 2

resonates with the period  $T_0$ .

On the other hand, when a call is received from the registered caller, the incoming call is detected by the incoming call detecting circuit 53, whereupon the control  
5 circuit 54 prepares a mode notifying command signal for giving a command to notify the user of reception of the call and feeds the command signal to the control signal preparing circuit 72. The circuit 72 in turn controls the period change-over unit 7 of the modulation signal  
10 generating circuit 56, whereby a modulation signal of sawtooth waves having a predetermined period  $T_0$  is generated as shown in FIG. 17, (a), and the on/off switch 71 is turned on and off at a predetermined period  $T_1$  as shown in FIG. 17, (b). An intermittent drive signal with  
15 on/off repetitions as shown in FIG. 17, (c) is fed to the notifying unit 2. As a result, the notifying unit 2 resonates during the on-period of the drive signal and ceases to resonate during the off-period thereof. This enables the user to recognize the incoming call from the  
20 registered person.

In the case where the portable telephone has three operation modes for use as such, a pager and tranceiver and when the telephone is set in the operation mode of telephone, the control signal preparing circuit 72 controls

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the period change-over unit 7 of the modulation signal generating circuit 56 in response to an incoming call, whereby a modulation signal of sawtooth waves having a predetermined period T2 is generated as shown in FIG. 18, (a), and the on/off switch 71 is held on at all times. A drive signal varying in frequency in accordance with the modulation signal is fed to the notifying unit 2. As a result, the notifying unit 2 resonates at the period T2.

On the other hand, when the telephone is set in the operation mode of pager, the control signal preparing circuit 72 controls the period change-over unit 7 of the modulation signal generating circuit 56, whereby a modulation signal of sawtooth waves having a predetermined period T3 is generated as shown in FIG. 18, (b), and the on/off switch 71 is held on at all times. A drive signal varying in frequency in accordance with the modulation signal is fed to the notifying unit 2. As a result, the notifying unit 2 resonates at the period T3 which is different from that of FIG. 18, (a).

Further when the telephone is set in the operation mode of transceiver, the control signal preparing circuit 72 controls the period change-over unit 7 of the modulation signal generating circuit 56, whereby a modulation signal of sawtooth waves having a predetermined period T2 is

generated as shown in FIG. 18, (a), and the on/off switch 71 is turned on and off at a predetermined period T4. A drive signal with on/off repetitions at the period T4 as seen in FIG. 18, (c) is therefore fed to the notifying unit

5 2. Consequently, the notifying unit 2 resonates during the on-period of the drive signal and ceases to resonate during the off-period of thereof, intermittently resonating periodically.

Accordingly the different states of vibration

10 described enable the user to recognize the incoming call in the particular operation mode.

The on/off switch 71 turned on and off by the control signal preparing circuit 72, preferably as timed with the rise and fall of the frequency variation of the modulation

15 signal as shown in FIGS. 17, (c) and 18, (c).

As described above, with the portable telephone according to the invention, periodic or nonperiodic occurrence of resonance repeatedly increases the amplitude of the vibrator to the amplitude of resonance as a peak and

20 decreases the amplitude from the peak, giving effective notification which is audible or perceivable by the human body. Moreover different states of vibration enable the user to identify the contents of notification.

The device and system of the present invention are not

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limited to the foregoing embodiments in construction but can be modified variously within the technical scope set forth in the appended claims. For example, the present invention is not limited to the notifying unit 2 having  
5 both a sound generator and a vibration generator in combination but can be applied also to a notifying device comprising a sound generator and a vibration generator as separate components. Furthermore, the vibrator of the notifying unit 2 is not limited to one utilizing a magnetic  
10 force but can be of any of various known constructions utilizing resonance. For example, one utilizing a piezoelectric element is usable.

According to the first embodiment, it is possible to use a microcomputer for constituting the vibration signal  
15 preparing circuit 5 and to prepare a modulation drive signal Dv like the one shown in FIG. 4 by software processing. It is also possible to use a microcomputer for providing the vibration signal preparing circuit 5 and the on/off switch 71 and to prepare the drive signal by  
20 software processing.

Further the contents of the notification to be made by the different states of vibration according to the second embodiment are not limited to the operation modes at the time of receiving incoming calls; the user can be thus

notified, for example, of a battery voltage drop for alerting and various functional operations. Furthermore, the on/off control and on/off-period change-over of the drive signal shown in FIG. 17, (a), (c), can be combined  
5 with the change-over of variation period of the drive signal shown in FIG. 18, (a), (b) for the notification of many operations.

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What is claimed is:

1. A notifying device comprising a vibrator to be resonated by a drive signal fed thereto, and a signal preparing circuit for feeding the drive signal to the vibrator, the notifying device being characterized in that the signal preparing circuit prepares a drive signal varying in frequency within a predetermined range including the resonance frequency of the vibrator and feeds the drive signal to the vibrator.
2. A notifying device according to claim 1 wherein the variation of the frequency of the drive signal corresponds to a variation in the resonance frequency of the vibrator due to tolerances of specifications on which the resonance frequency is dependent.
3. A notifying device according to claim 1 or 2 wherein the resonance frequency of the vibrator is a low frequency of up to hundreds of hertz, and the vibration of the vibrator has at the resonance frequency an amplitude generally perceivable by the human body.
4. A notifying device according to any one of claims 1 to 3 wherein the drive signal has an alternating waveform of rectangular waves or sine waves having a frequency periodically varying at 0.5 to 10 Hz.

5. A notifying device according to claim 4 wherein the frequency of the drive signal periodically varies at 1.37 to 2.98 Hz.

6. A notifying device according to claim 5 wherein the  
5 frequency of the drive signal periodically varies at 2.18 Hz.

7. A notifying device according to any one of claims 1 to 6 wherein the frequency of the drive signal varies in the form of triangular waves, sine waves or sawtooth waves  
10 having the definite range as the amplitude thereof.

8. A notifying device according to any one of claims 1 to 7 wherein the frequency of the drive signal gradually increases or gradually decreases stepwise within the definite range.

15 9. A notifying device according to any one of claims 1 to 8 wherein the vibrator comprises a casing, a diaphragm having a fixed end on an inner peripheral wall of the casing, a magnet attached to a free end of the diaphragm, and a coil disposed as opposed to the magnet, and the drive  
20 signal is fed to the coil.

10. A wireless communications system comprising a notifying device for notifying the user of incoming calls, the notifying device comprising a vibrator to be resonated

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by a drive signal fed thereto, and a signal preparing circuit for feeding the drive signal to the vibrator, the wireless communications system being characterized in that the signal preparing circuit prepares a drive signal  
5 varying in frequency within a predetermined range including the resonance frequency of the vibrator and feeds the drive signal to the vibrator.

11. A wireless communications system having incorporated therein a notifying device for performing  
10 different kinds of notifying operations including notification of incoming calls, the notifying device comprising a vibrator to be resonated by a drive signal fed thereto, and a drive signal feed circuit for feeding the drive signal to the vibrator, the wireless communications  
15 system being characterized in that the drive signal feed circuit comprises:

command signal preparing means for preparing notification command signals which are different for different contents of notification in conformity with the content, and  
20 drive signal preparing means operative in response to the notification command signal to prepare a drive signal which varies in frequency within a determined range including the resonance frequency of the vibrator and which differs in

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## ABSTRACT

In a notifying device comprising a notifying unit 2 having incorporated therein a vibrator to be resonated by a drive signal fed thereto, and a signal preparing circuit 5 for feeding the drive signal to the notifying unit 2, the signal preparing circuit 5 prepares a drive signal  $D_v$  varying in frequency within a predetermined range including the resonance frequency of the vibrator of the unit 2 and feeds the signal to the notifying unit 2. The variation of frequency of the drive signal is determined in correspond relation with a variation in the resonance frequency of the vibrator due to tolerances for specifications which govern the resonance frequency. The drive signal has an alternating waveform of rectangular waves or sine waves, and the frequency thereof varies periodically from 1.37 to 2.98 Hz. The notifying device achieves a satisfactory notifying effect despite the variation of the resonance frequency of the vibrator.

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FIG. 1

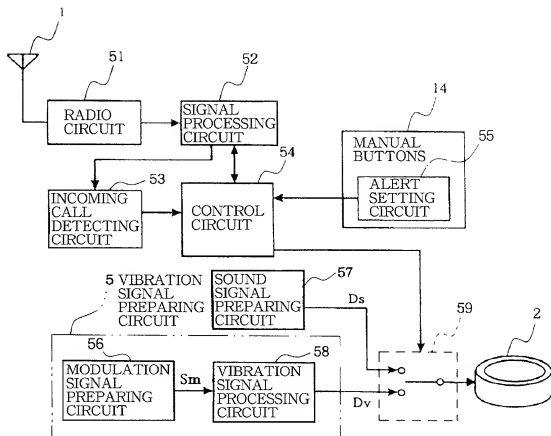


FIG. 2

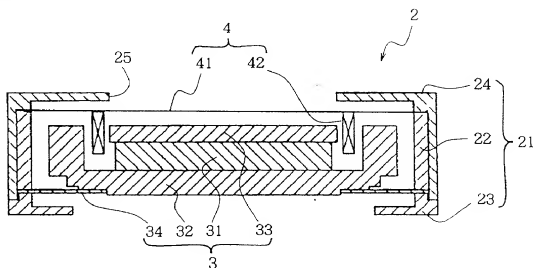


FIG. 3

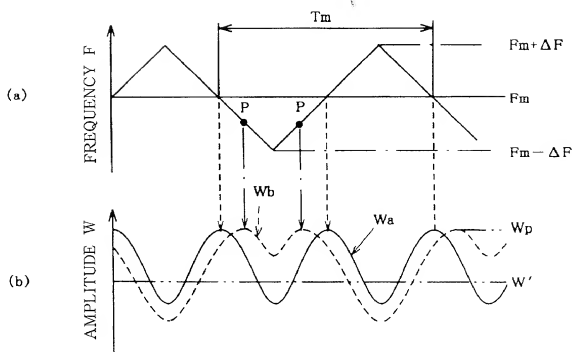


FIG. 4

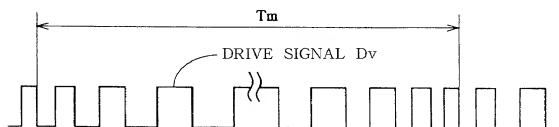


FIG. 5

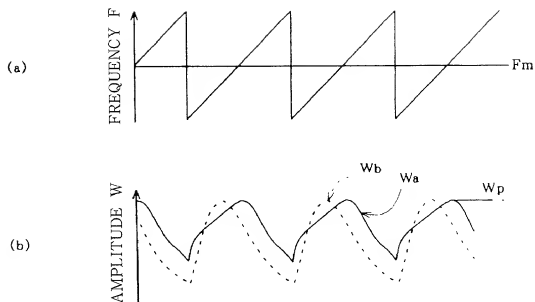


FIG. 6

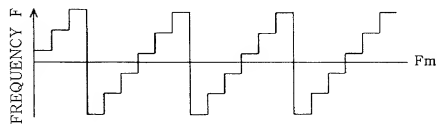


FIG. 7

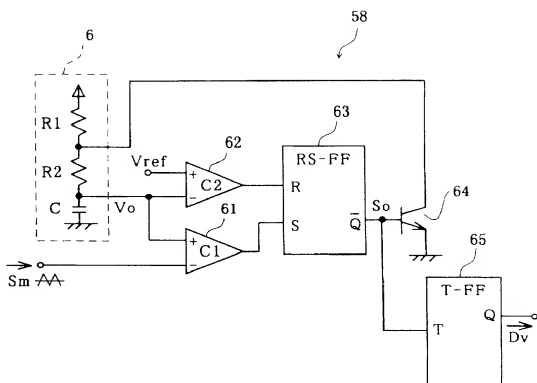


FIG. 8

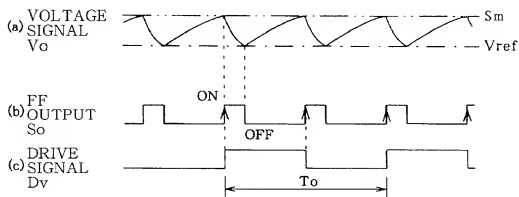


FIG. 9

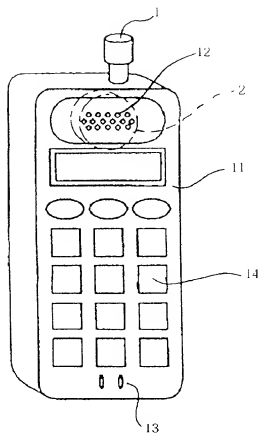
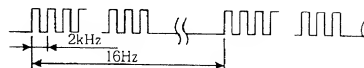
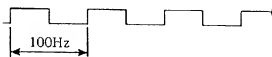


FIG. 10

(a) SOUND DRIVE  
SIGNAL  $D_s$



(b) VIBRATION DRIVE  
SIGNAL  $D_v$



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FIG. 11

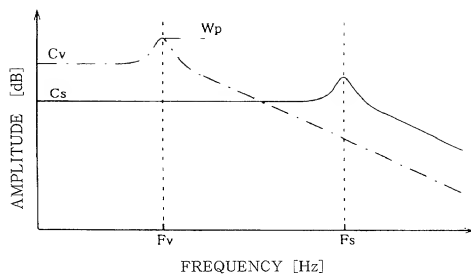


FIG. 12

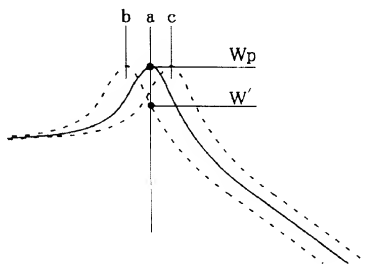


FIG. 13

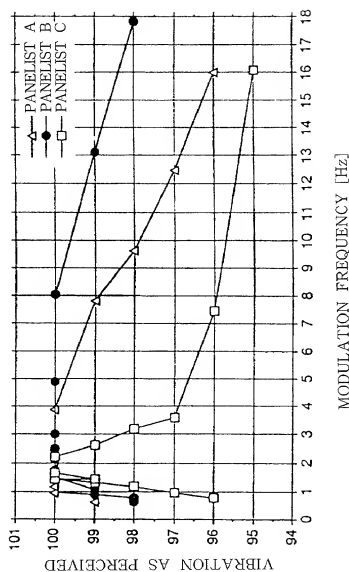


FIG. 14

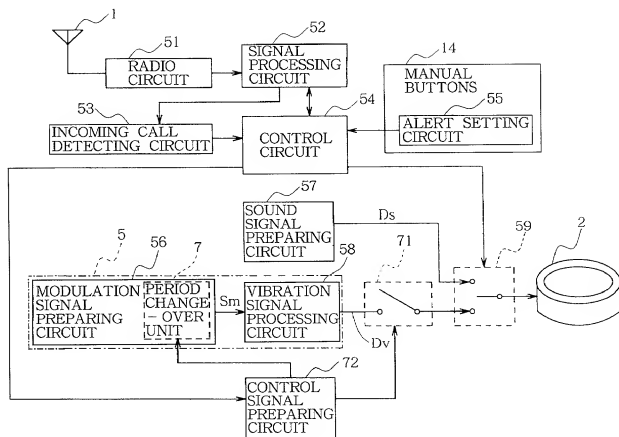


FIG. 15

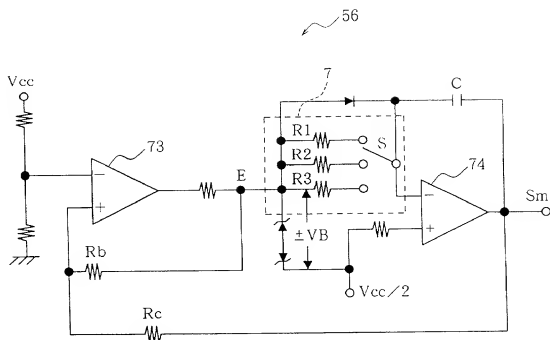


FIG. 16

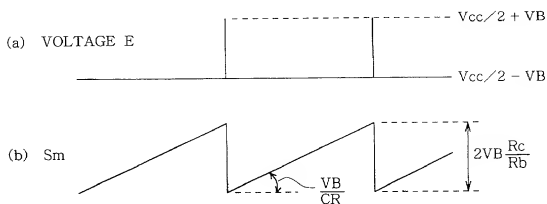


FIG. 17

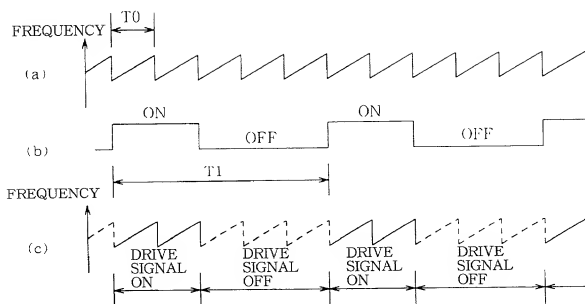
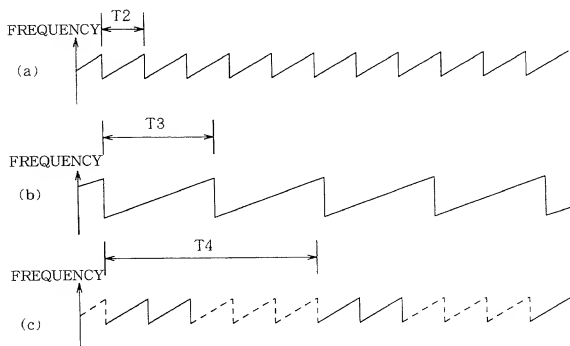


FIG. 18



# Declaration For U.S. Patent Application

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled  
(Insert Title) NOTIFYING DEVICE AND WIRELESS COMMUNICATIONS SYSTEM INCORPORATING SAME

the specification of which is attached hereto unless the following is checked:

☒

was filed on DECEMBER 28, 1998 as United States Application Number or PCT International  
Application Number PCT/JP98/06014 and was amended on \_\_\_\_\_  
(if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 (a) - (d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

(List prior foreign applications. See note A on back of this page)

HEL10 - 002501	Japan
(Number)	(Country)
HEL10 - 105276	Japan
(Number)	(Country)
HEL10 - 266748	Japan
(Number)	(Country)
(Number)	(Country)

08/01/1998
(Day/Month/Year Filed)
16/04/1998
(Day/Month/Year Filed)
21/09/1998
(Day/Month/Year Filed)
(Day/Month/Year Filed)

Priority Claimed  
☒ Yes ☐ No  
☒ Yes ☐ No  
☒ Yes ☐ No  
☐ Yes ☐ No

(See note B on back of this page)

☐ See attached list for additional prior foreign applications

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

(Application Number)
(Application Number)

(Filing Date)
(Filing Date)

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of the application:

(List Prior U.S. Applications)

(Application Serial Number)
(Application Serial Number)

(Filing Date)
(Filing Date)

(Status) (patented, pending, abandoned)
(Status) (patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Title 18 of the United States Code, § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Full name of seventh inventor (given name, family name) \_\_\_\_\_  
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Post Office Address \_\_\_\_\_

Full name of eighth inventor (given name, family name) \_\_\_\_\_  
Inventor's Signature \_\_\_\_\_ Date \_\_\_\_\_  
Residence \_\_\_\_\_ Citizenship \_\_\_\_\_  
Post Office Address \_\_\_\_\_